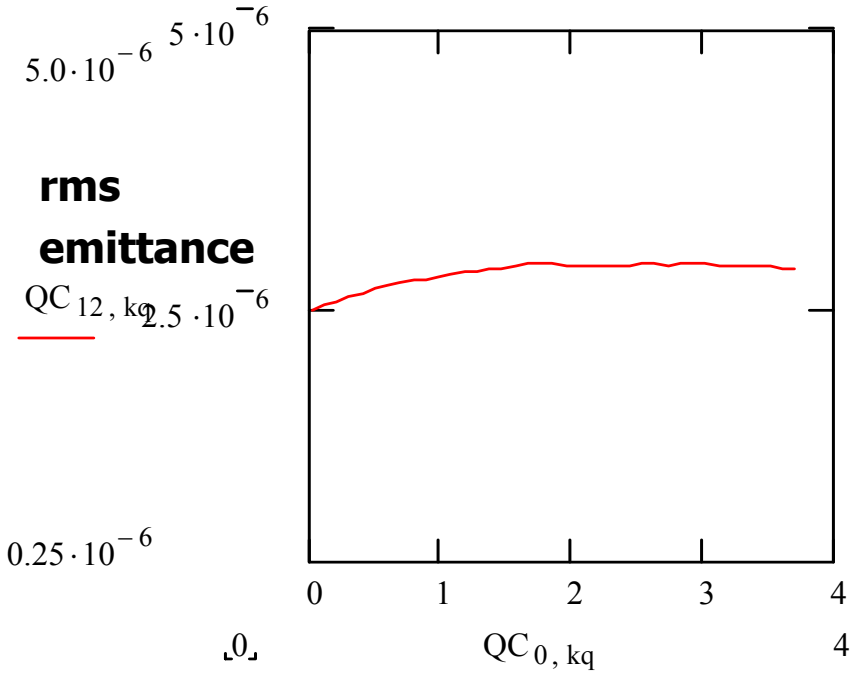
Changes in cooling due to recent developments in SimCool code

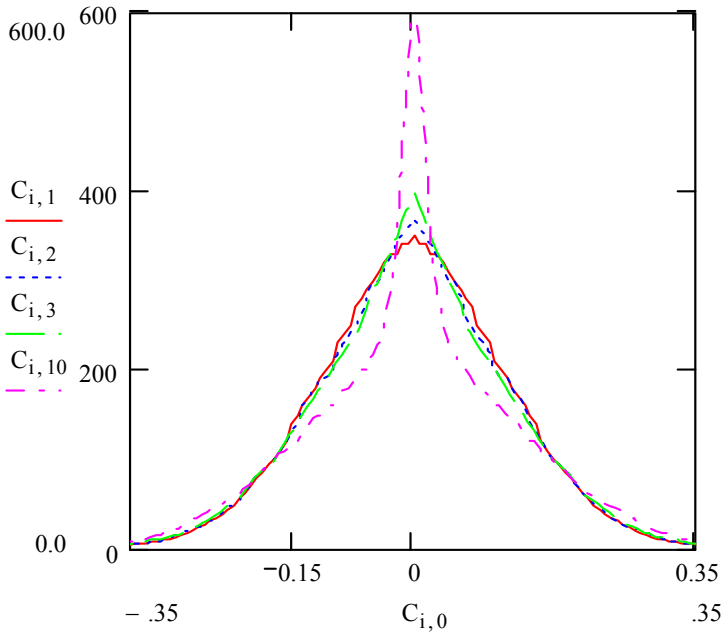
Major changes during November'2003-February'2004:

1. **Synchrotron motion was added.**
2. **IBS diffusion coefficients were adjusted, dispersion was included in transverse IBS growth rates.**
3. **Calculation of electron density for both Gaussian and uniform beam with corresponding ratio of electron bunch length/ ion bunch length.**

Had some (insignificant) effect on cooling of beam core.

Old parameters, SimCool results with changes done November'03 - February'04





Old (2001-2003) baseline parameters: ε_t=30*10^{-6}, B=1T, $\sigma_{se}=\sigma_{si}$, L=30 m

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1. Old parameter were unsufficient to produce significant reduction of rms or 95% emittances, as well as rms bunch length.

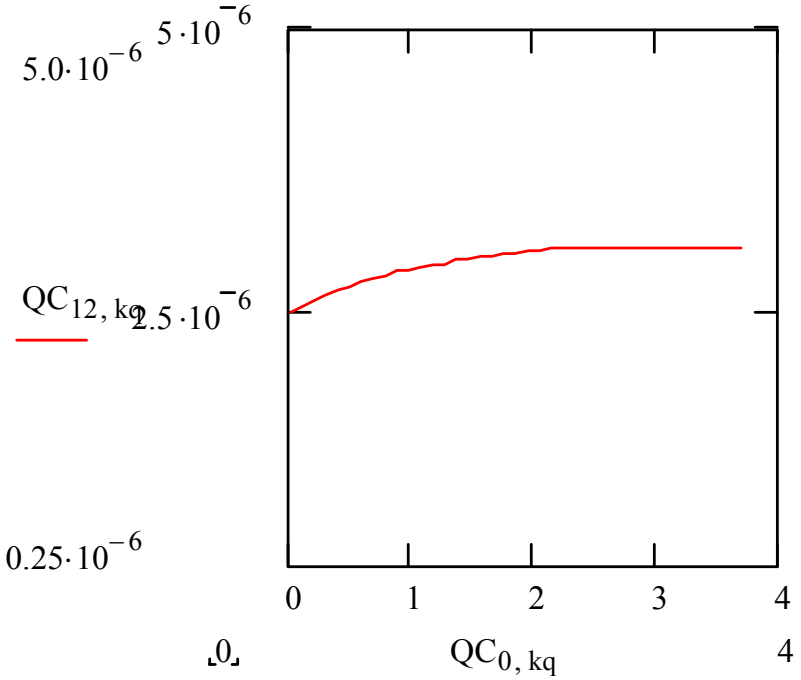
2. But significant luminosity gain could be still achieved due to effective cooling of beam core.

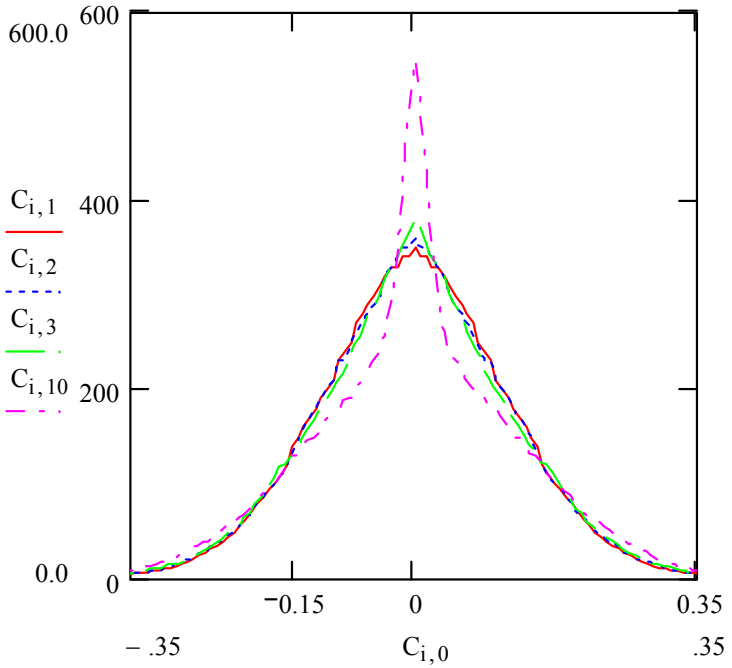
Presented at MAC'04

Additional changes in the code: March-April' 2004

These changes are small by itself, but for our region of small cooling logarithm they make a big difference.

1. Maximum impact parameter is decreased by taken into account plasma frequency (electron density) in calculations





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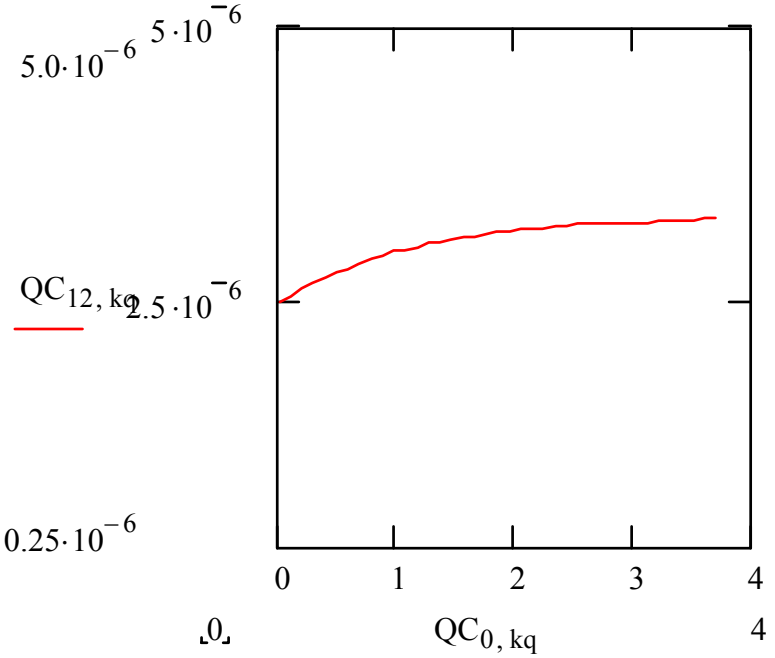
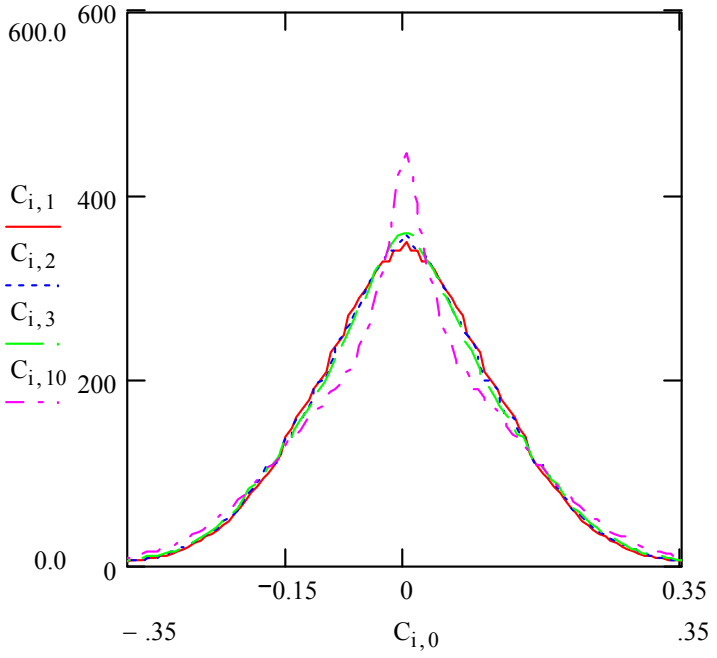
2. Additional factor sqrt[2] (missing before) was added in calculation of transverse velocity of electrons.





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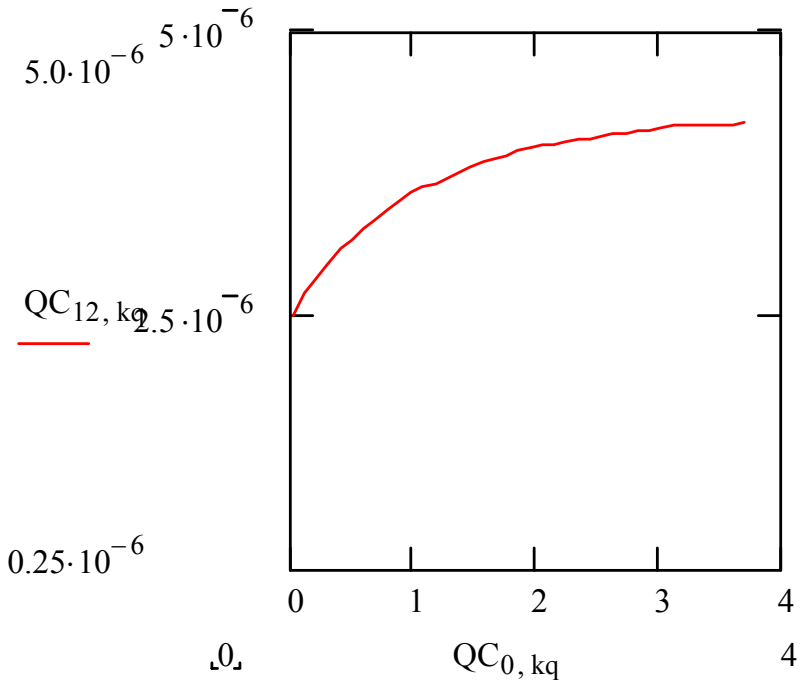
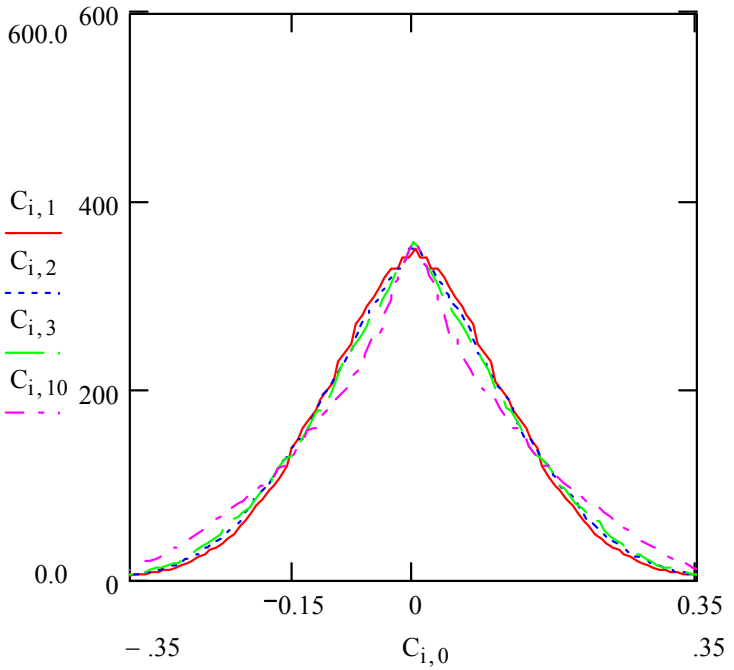
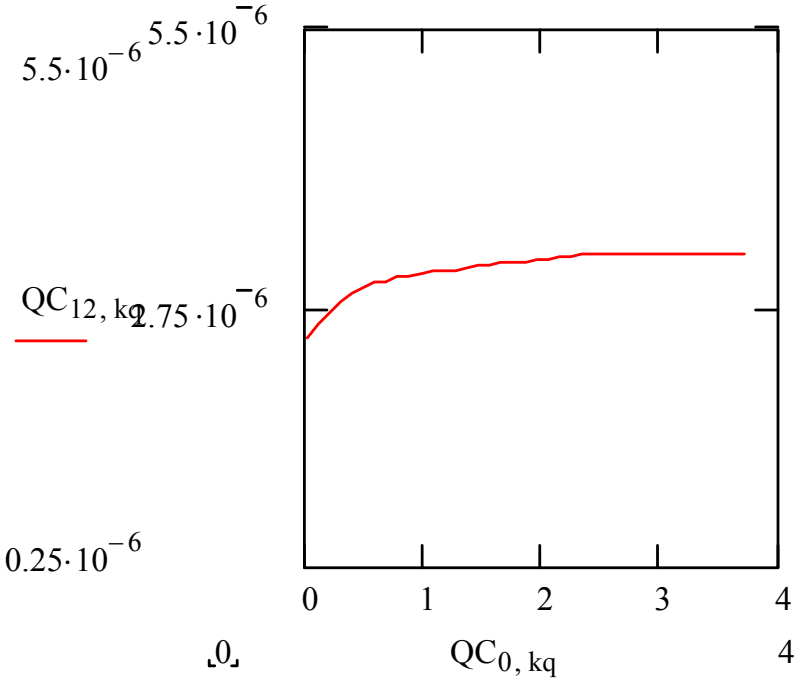
3. New calculation of IBS for distribution with a cold core

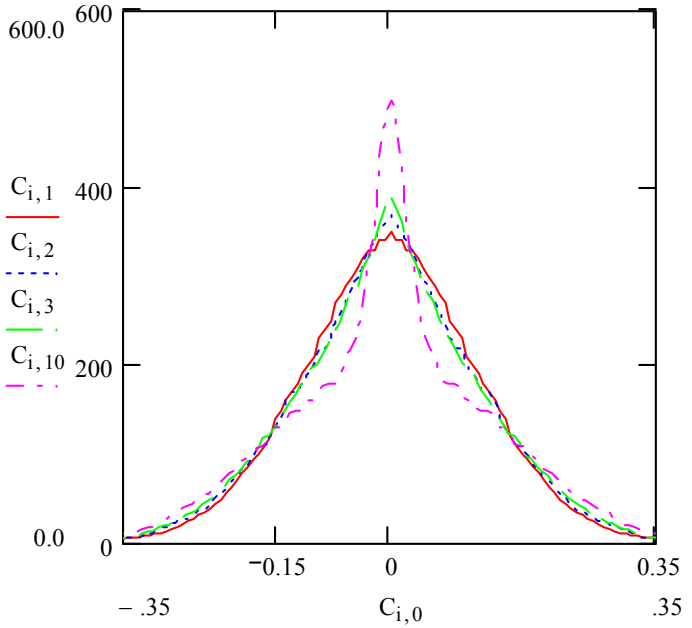




Net result of changes 1+2+3 – no rapid cooling with old parameters – need some optimization of parameters to get cooling back (next slide)

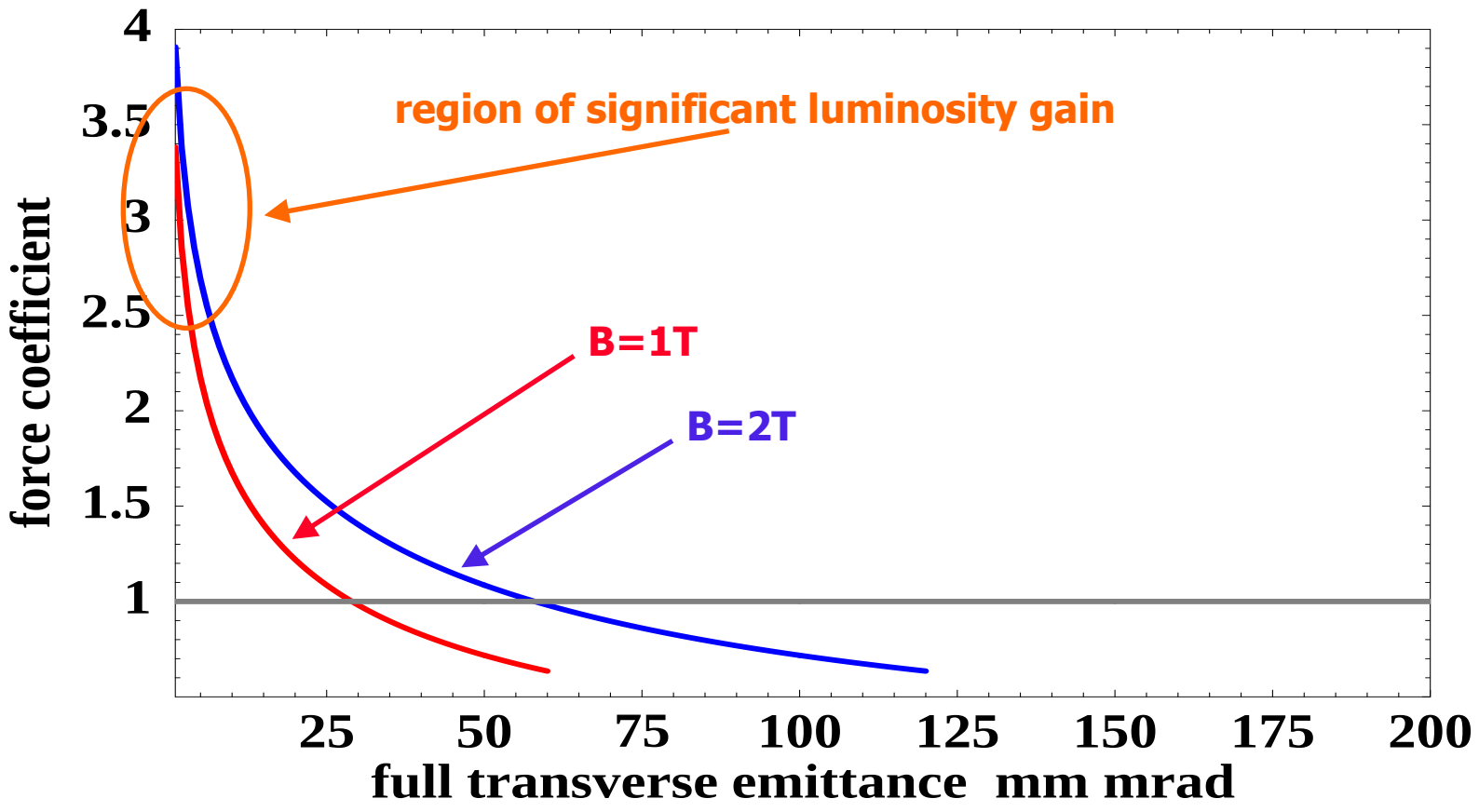
Example: q increased to 20nC, B=2T



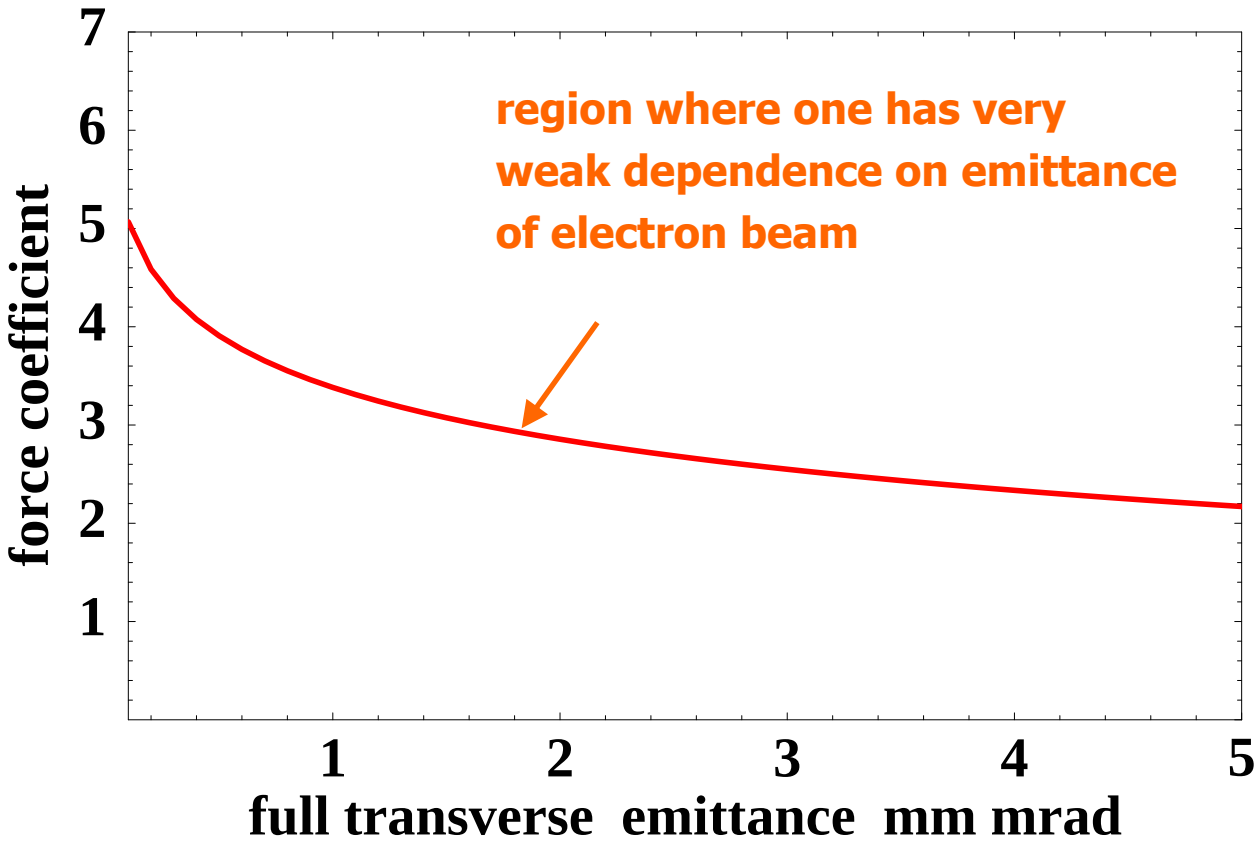


Cooling is back – in the assumption that small emittance of electron beam can be achieved (see slides on "requirements on beam emittance")

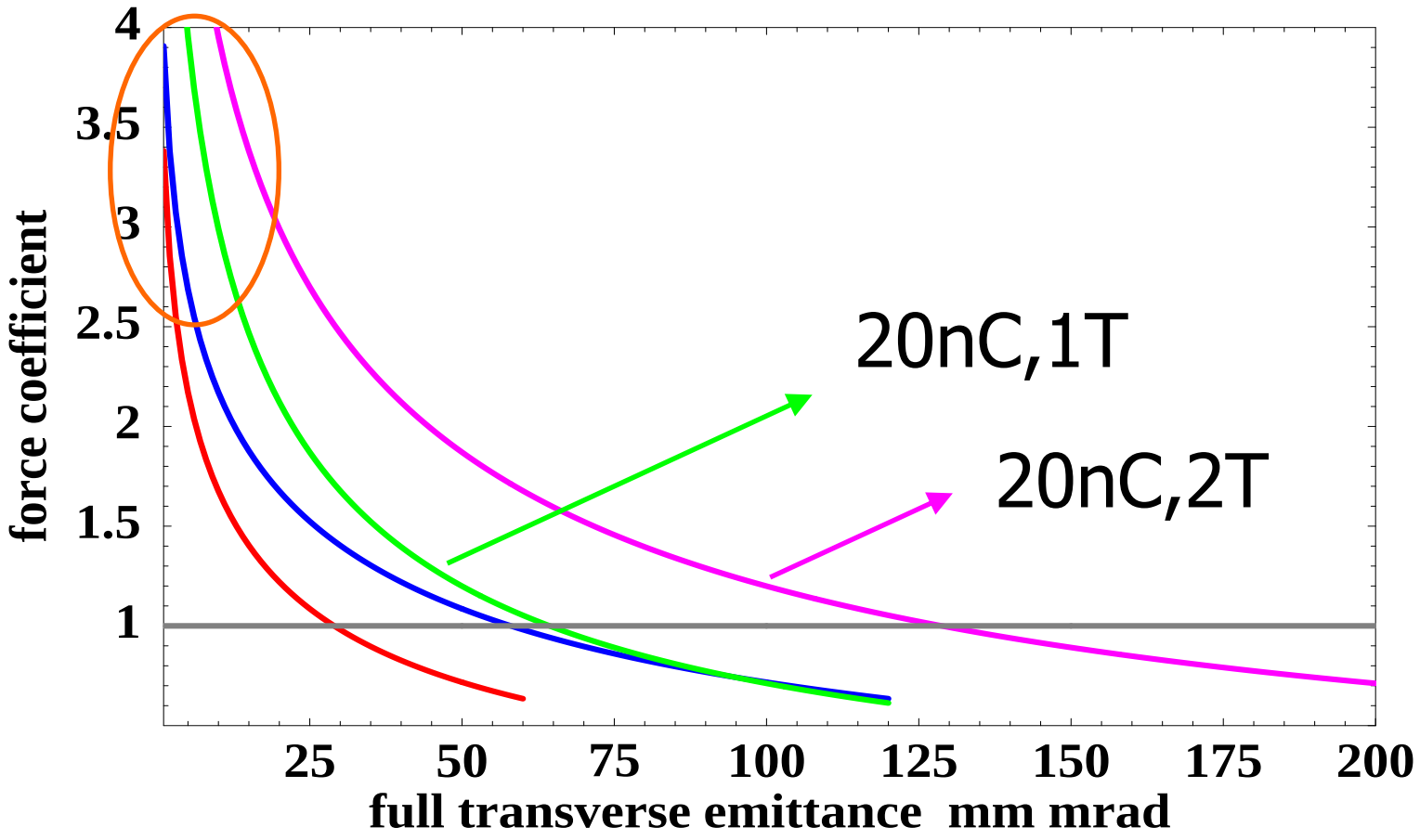
q=10 nC


region of significant luminosity gain
B=1T
B=2T
force coefficient
4
3.5
3
2.5
2
1.5
1
25
50
75
100
125
150
175
200
full transverse emittance mm mrad

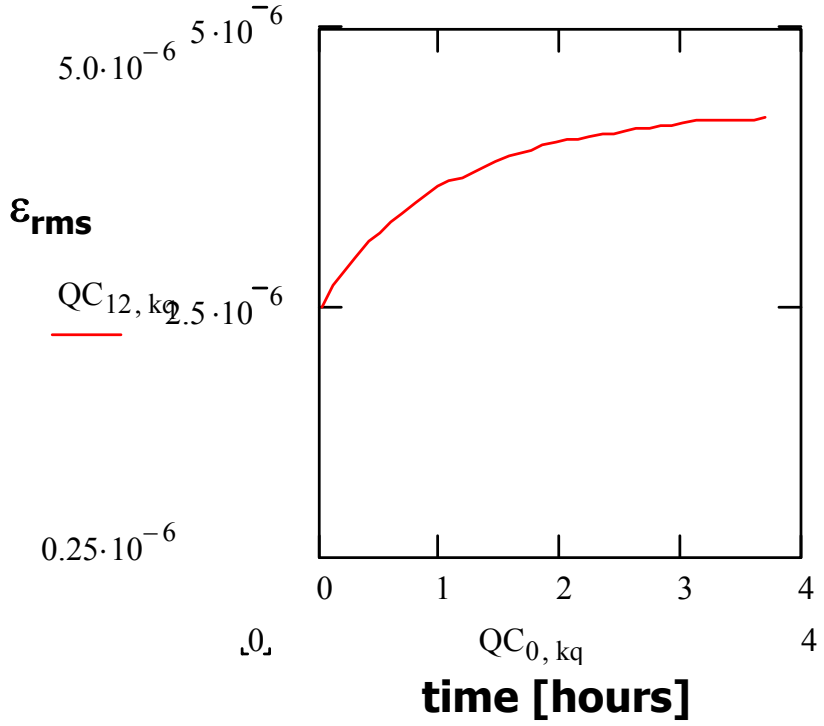
Large cooling Log region (very small emittances)

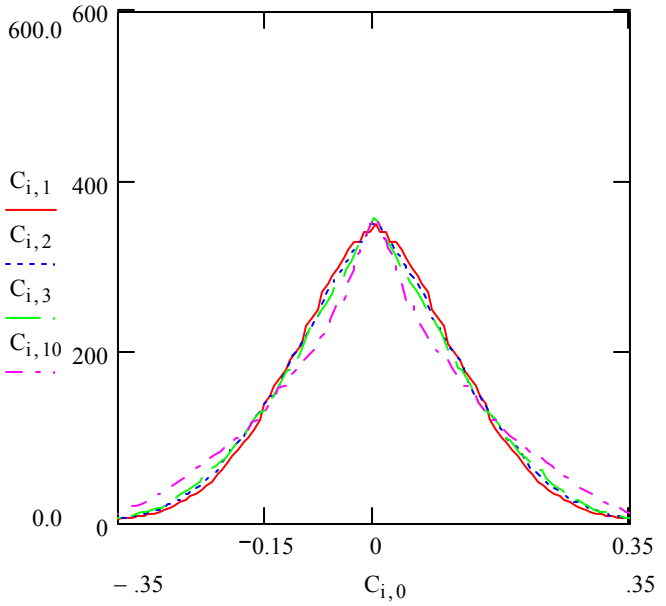


Charge 10 & 20 nC



10 nC, ε_x=15e-6, ε_t=30e-6 (B=2T)





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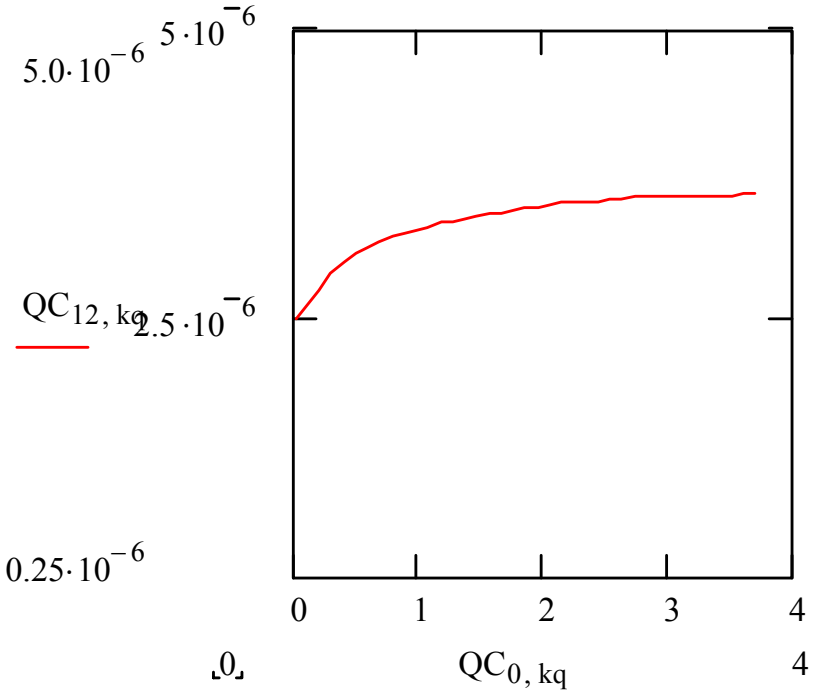
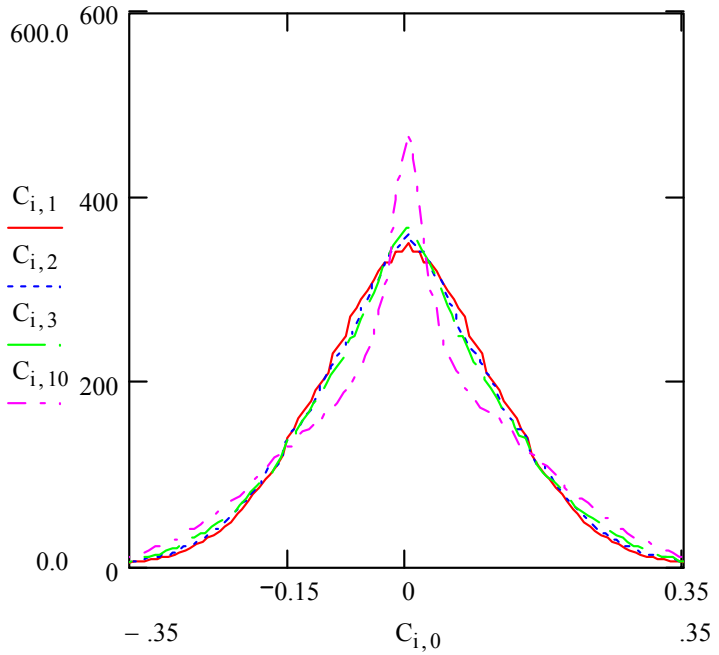
10 nC, ε_x=5e-6, ε_t=10e-6 (B=2T)





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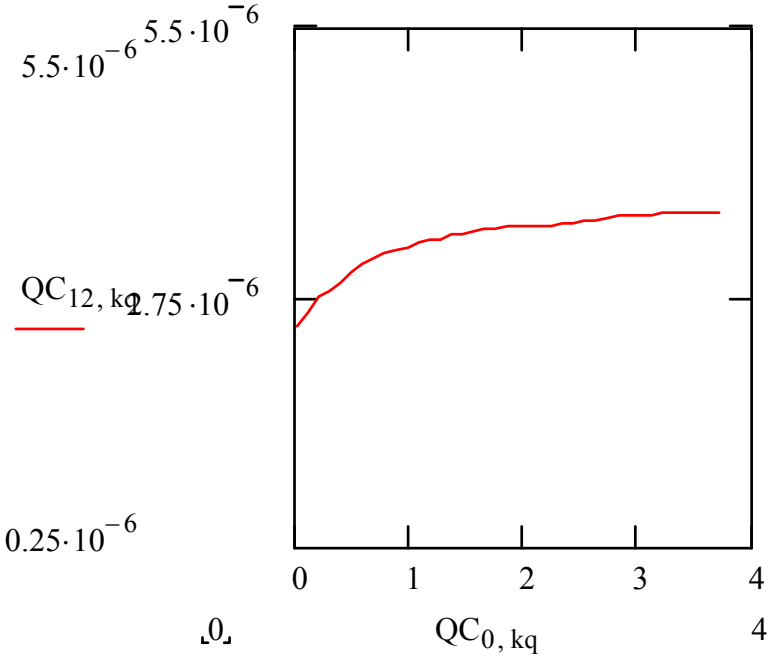
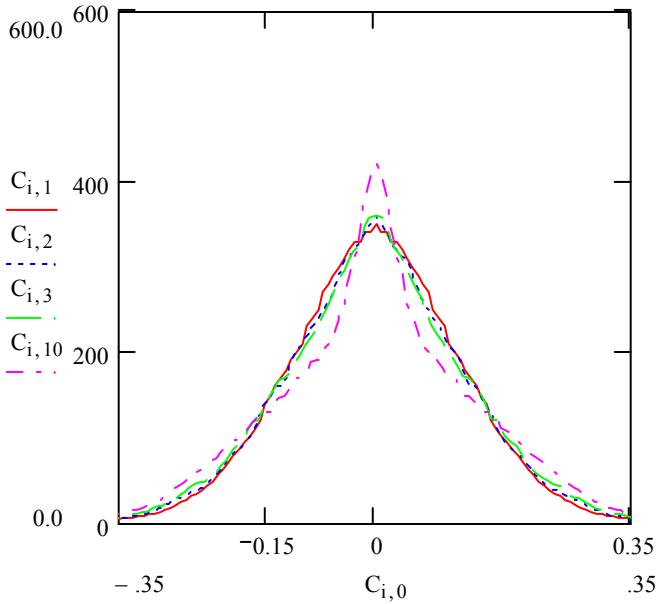
20 nC, ε_x=25e-6, ε_t=50e-6 (B=2T)





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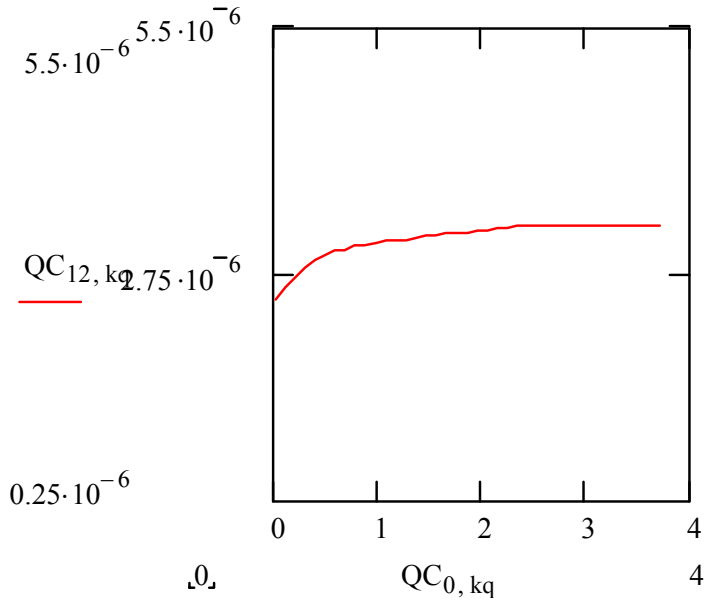
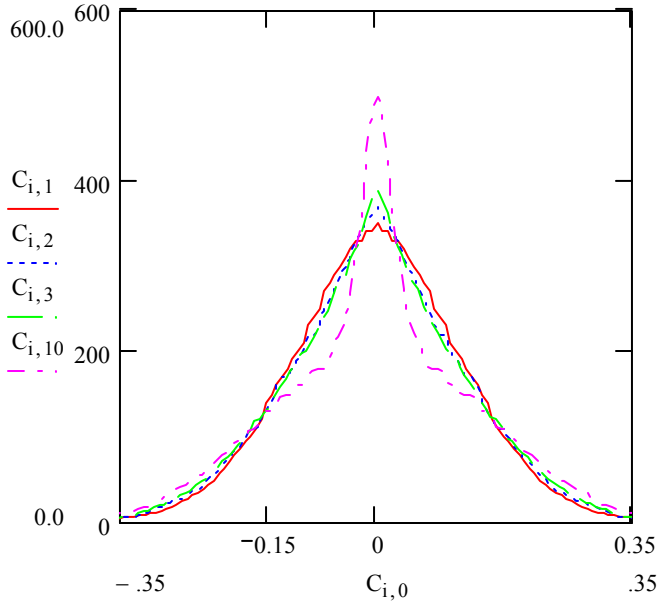
20nC, ε_x=15e-6, ε_t=30e-6 (B=2T)





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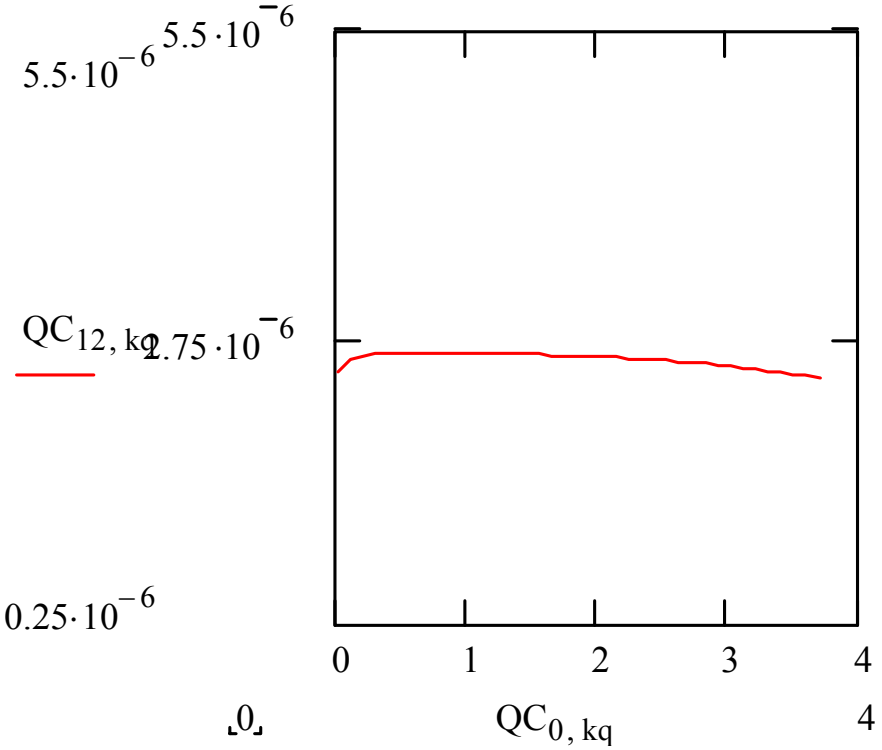
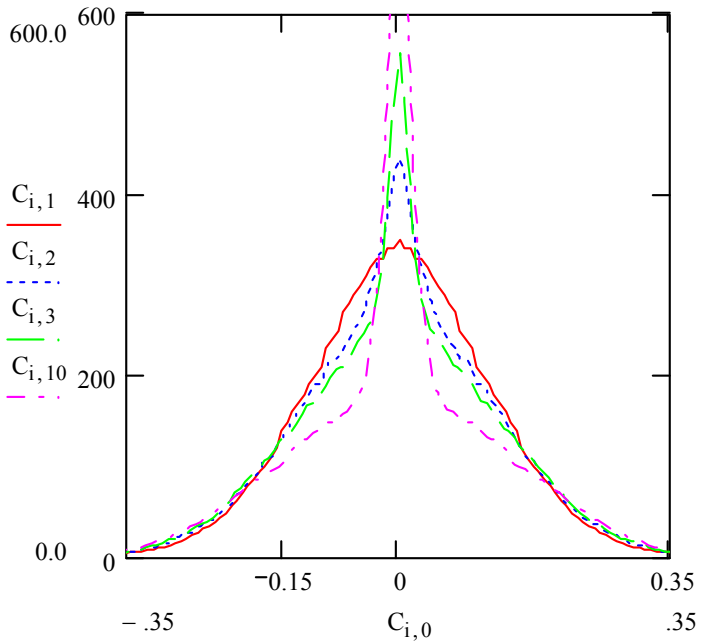
q=20nC, B=4T, ε_x=10*10^{-6}





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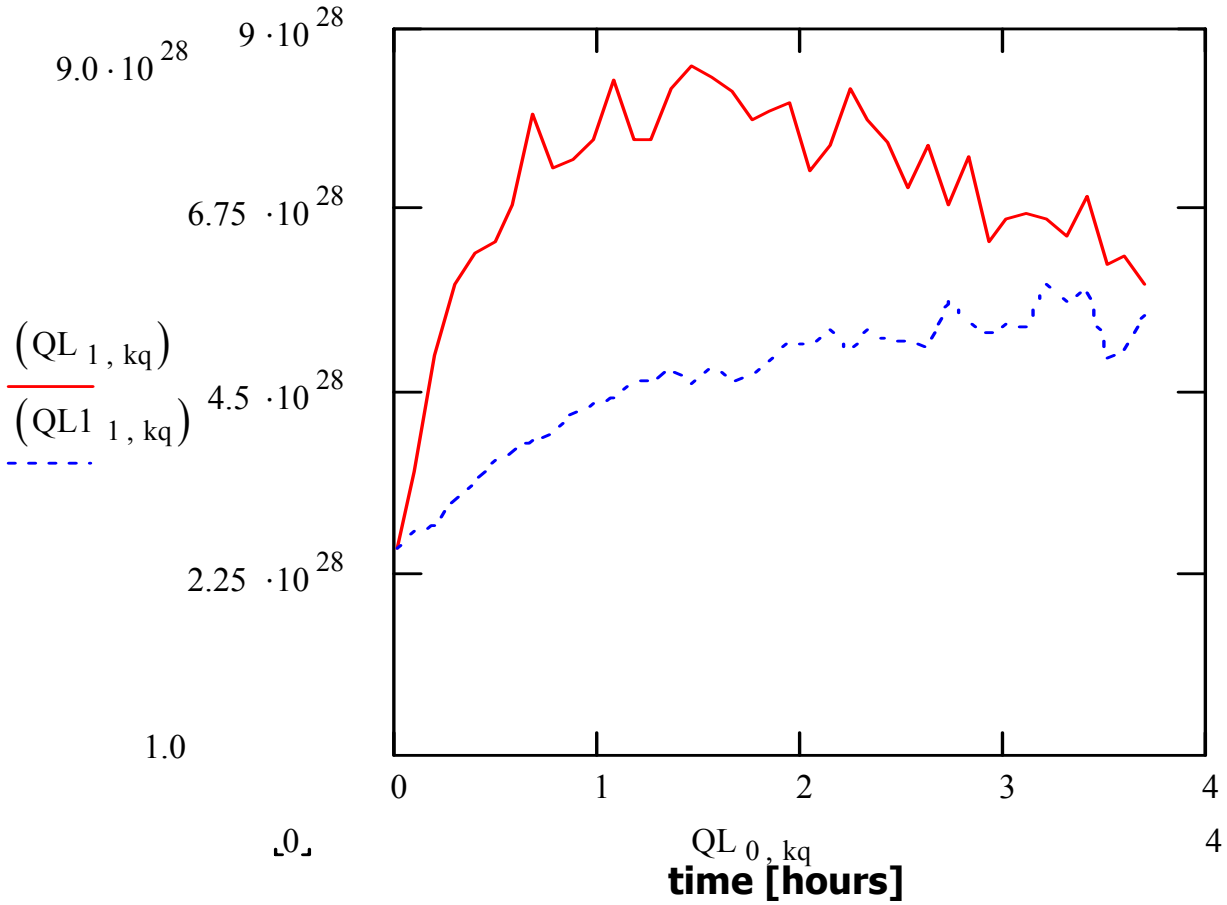
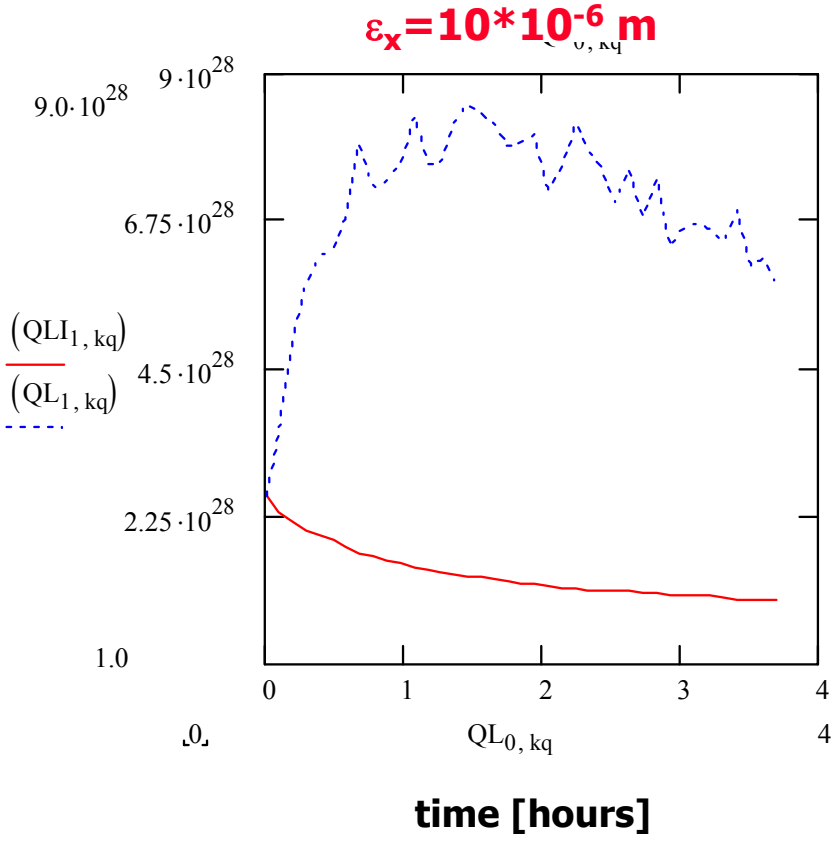
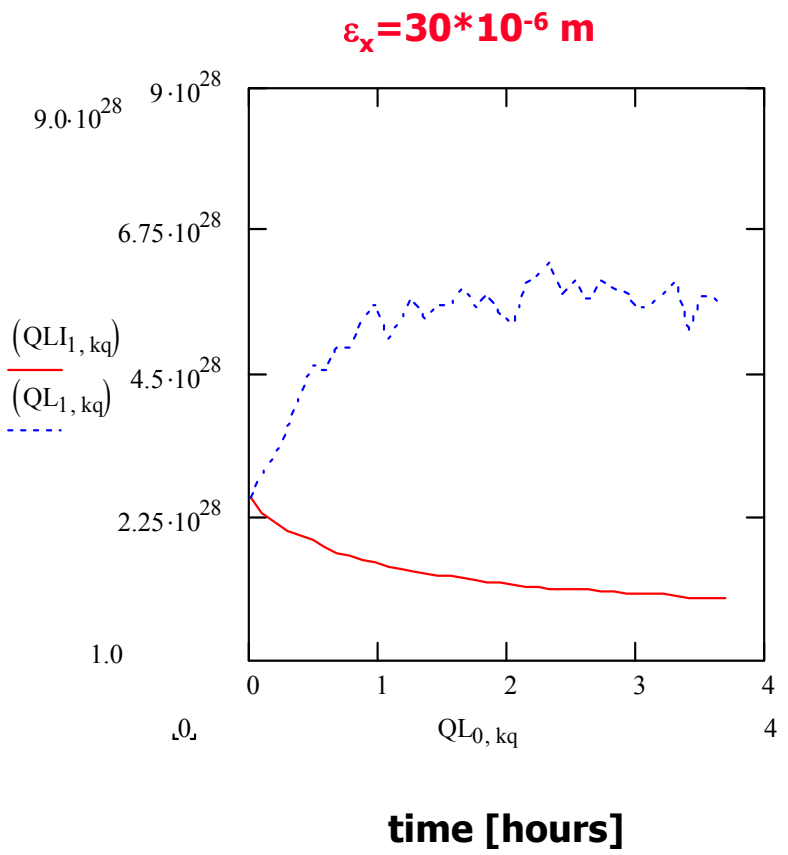
B=4T , ε_x=10*10^{-6} – luminosity increase due to optimization of electron beam parameters



B=5 T – luminosity (350 bunches) increase for various emittances of electron beam





Requirements on emittance of electron beam needed to achieve desired luminosity increase (for B=2, 4 and 5 T) with q=20nC